DOCUMENT RESUME

ED 396 734 IR 017 947

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TITLE Telematics for Higher Order Learning: Challenges and Opportunities.
PUB DATE 96
NOTE 8p.; In: Learning Technologies: Prospects and Pathways. Selected papers from EdTech '96 Biennial Conference of the Australian Society for Educational Technology (Melbourne, Australia, July 7-10, 1996); see IR 017 931.
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Development; *Distance Education; *Educational Development; Foreign Countries; Instructional Design; *Instructional Innovation; Rural Areas; Teaching Styles
IDENTIFIERS *Audiographics; Australia (Western Australia); *Telematics

ABSTRACT

A recent initiative by the Education Department of Western Australia is seeking to extend the use of telematics (audiographic teleconferencing) for delivery of educational services to gifted and talented students in rural and remote areas. The aim of the project is to extend and apply innovative approaches to teaching via audiographics, and to foster higher order learning in the students by linking them with other students in metropolitan and rural areas. This paper outlines an action research approach to developing a teaching-learning framework for application of telematics to learning environments seeking to promote higher order cognition. The limitations of telematics environments are noted along with the didactic teaching style adopted by many teachers as they try to accommodate their instruction to the medium. Challenges and opportunities that higher order learning presents to the telematics teacher are discussed. An instructional design framework for telematics teaching that orchestrates interactions leading to higher order learning is then described. The three dimensions of this framework focus on the role of the teacher in the learning process; the role of the student; and teaching strategies. (Contains 30 references.) (Author/AEF)

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Telematics for higher order learning: challenges and opportunities

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ED 396 734

In Western Australia telematics (audiographic teleconferencing) is used to deliver curriculum subjects to students in remote and rural locations. Communication between students and teachers is achieved by combining telephone, facsimile and computer links, and by providing different levels of teacher-student interaction. Teaching via telematics overcomes many of the problems of remote and distant learners as lessons are transmitted from the metropolitan area to a number of sites simultaneously.

Previous research on telematics classrooms (McLoughlin & Oliver, 1995) indicates limitations on the forms that teacher-student interactions can take, and in particular the didactic teaching style that teachers adopt when teaching with audiographics.

A recent initiative by the Education Department of Western Australia is seeking to extend the use of telematics for delivery of educational services to gifted and talented students in rural and remote areas. The aim of the project is to extend and apply innovative approaches to teaching via audiographics, and to foster higher order learning in the students by linking them with other students in the metropolitan and rural areas.

The paper will outline an action research approach to developing a teaching-learning framework for application of telematics to learning environments seeking to promote higher order cognition.

The Western Australian Context

Audiographic teleconferencing, or telematics is widely used in Western Australia to deliver educational programs to rural and isolated schools. The technology combines computers for sharing graphics, telephones for two-way communication and facsimile for document transmission. The potential of telematics to deliver interactive and efficient instruction to remote sites is documented in the literature (Oliver & Reeves, 1994; Rehn, 1994; Stacey 1993: Oliver & McLoughlin 1995). In Western Australia, telematics normally refers to the use of a computer using the software *Electronic Classroom* . What distinguishes telematics is that audio, document and visual links are created via the technology. The learning environment does not enable face-to-face visual links between teacher and learner, and communication is mediated through visual and audio links.

Current Development in WA: The Academic Talent Program

In WA telematics has been used to:

(i) extend the curriculum subjects offered throughout rural areas. Clusters of schools have organised themselves to share resources and teachers so that all participating schools have access to a broader range of subjects. This was subsequently known as the Priority Country area program (PCAP).

(ii) to enable schools in rural areas (on the basis of equity and access) to receive specialist programs, such as LOTE; (Japanese, Italian and French are currently offered);

(iii) provide schools in rural areas the opportunity to have a specialised curriculum, (as part of the Academic Talent Program) via telematics and to have access to the same range of programs as

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schools in the metropolitan area. In addition, it is anticipated that by linking schools in the metropolitan and country areas, talented and gifted students will benefit from collaborative activities and exchange of views.

The Academic Talent Program via Telematics

The curriculum frameworks for the Academic Talent Program (ATP) were developed to encourage and support the development of students' cognitive, social and emotional well being regardless of location, gender or social class. The curriculum frameworks are couched in terms of outcomes, or performance and demonstrated ability. Outcomes based education has the following characteristics (Willis, 1994).

- An outcome is a demonstration of learning that occurs as a result of a learning experience.
- Outcomes-based education is based on specific outcomes. Curricula are designed to achieve such outcomes. Courses are evaluated in terms of their capacity to help students' attain stated objectives.
- The academic talent program, in addition to espousing outcome statements, also seeks to develop as integrated curriculum by extending relationships between the disciplines.

The particular higher-order learning outcomes as stated in the curriculum framework involve:

- independent learning strategies
- information handling and synthesis
- independent learning
- reflection and analysis to generate and refine knowledge
- question generation and analysis
- presentation of arguments
- effective communication
- participation in group work.

Teachers are provided with curriculum guidelines enabling them to develop teaching programs which extend, enrich and accelerate talented students in a special program tailored to their needs. The provision of such a program via telematics presents interesting challenges.

Telematics as Medium for delivery of Educational Programs

Research into the effectiveness of audiographics as a medium for delivery has yielded considerable insight into the pedagogic practices of teachers, their attitudes towards implementing the technology and the constraints it imposes (Stacey, 1993; 1994). In distinct education, communication between the teacher and the learners is still the critical features of the learning process, though it is mediated electronically in telematics. Pervasive in the literature is the belief that telematics is "second best", a poor-alternative to face-to-face teaching. Not surprisingly, such negative attitudes are likely to affect teachers' perceptions of the effectiveness of the technology.

Many of the guides to telematics teaching stress the need for a facilitating role for the teacher (Elliott, 1991; Conboy 1992, 1991) and a consequent reliance on student responsibility, resource based approaches and expectations that students will assume responsibility to a greater extent than they would in a classroom. It has also been observed that students must take more responsibility for their own learning as the physical absence of the teacher means that students have to take the initiative to ensure that equipment is functioning, provide feedback to the teacher on how the lesson is being received. For teachers, some of the difficulties documented included:

- conducting an effective lesson without eye contact
- trying to get to know students without seeing them
- lack of feedback from students
- feeling of pressure and stress in trying to involve all students actively
- lack of instant visual and graphical communication.

One of the contradictions that emerges from the research on telematics teaching is that while teachers depend on highly motivated, co-operative students for the success of the lessons, they rarely make their lessons fully learner-centred, and persist in retaining control over the pace and sequence of interactions at all stages. The inherent contradiction between the desire to achieve a motivating,

interactive learner-centred environment and the effort made by teachers to maintain control over all aspects of teleteaching is another striking feature of reports on telematics classrooms.

Interactions in Telematics Classrooms

In audiographics environments, studies (Oliver and Reeves 1994; Evans and Nation, 1992) indicate that limitations on interactions often result from the technology, the teacher's management strategies, or a combination of both. Didactic forms of teaching are observed to be prevalent. Evans and Nation (1992) reported that their observations confirmed that teachers felt compelled to use the audio link to compensate for lack of visual cues and this resulted in the lessons being didactic and interrogative. The adoption of a teacher centred approach was evident in teachers' persistent questioning of students. Clearly, the main agenda for teachers was maintaining control and discipline in their teaching and the technologies appeared to support this approach.

These findings are confirmed by Oliver & Reeves (1994) who reported that teachers exerted control over the dialogue through :

- leading questions that required no answers;
- questions that were answered by the teachers after short delays;
- questions that could not be answered;
- setting task for students; *and*
- directives to individual students.

It was also observed that there was an inverse relationship between teacher dialogue and student verbalisation throughout the lesson: as student responses diminished, teacher talk increased, resulting in a decrease in interactivity. These findings are related to the critical link between learner control and interactivity. If there is asymmetry in power relations and control of dialogue, meaningful teacher-student and student-student interaction will not ensue .

In reporting on teachers' experiences, Squires and Sinclair (1993) reported that teachers very strongly felt the absence of visual cues. Given the importance of non-verbal exchanges in communications generally, this is hardly surprising. Changes to teaching strategies reported by instructors included:

- reliance on diagrams using the electronic classroom;
- need for clear instructions;
- more verbalisation;
- accurate time allocation and management;
- student centred approaches;
- use of aural cues;
- use of printed materials for a discussion focus;
- questions directed at particular students;
- advance planning.

These experiences appear to be widespread across contexts and locations. Observations of classrooms in Western Australia (Oliver & Reeves , 1994) and in Victoria (Evans & Nation, 1993) affirm that the pedagogies adopted by teachers using the technology are limited, interrogative and didactic, not conducive to searching or deep level inquiry by learners and narrow in range and focus. As a result, telematics classrooms tend to have a number of clearly identifiable characteristics. Teachers tend to take prime responsibility for setting the academic agenda, organising lessons and directing student behaviour. Consequently, classroom discourse is adversely affected, with students merely reproducing knowledge, or responding to questions posed by a teacher. The resulting pattern is one of initiation (I) by the teacher, response by a student (R) and evaluation (E) by a teacher. This IRE pattern has been acknowledged as typical of teacher fronted classrooms (Cazden 1988; Edwards & Mercer, 1987: Mehan 1979). Not only do teachers dominate classroom, they also control turns at talk. Opportunities for initiation, student -generated questioning and inquiry are constrained by this formalised pattern.

In summary, the literature (McLoughlin & Oliver, 1995) confirms that telematics environment tend to have the following characteristics:

(i) passive rather than active learning

(ii) teacher control over the pace, sequence and form of the lesson (learners are dependent on the teacher as a consequence of these pedagogies)
(iii) learners do not monitor their own performance.

Clearly there are challenges ahead to the implementation of a successful academic talent program using telematics as a medium for delivery.

Higher Order Learning: Challenges and Opportunities

What is higher order learning and what challenges does it present to the telematics teacher? Critical thinking is inherent in all academic tasks which involve reading, writing, arithmetic and problem solving. For example, writing involves the ability to analyse, synthesise and organise information, in addition to being able to monitor one's own performance.

Another view is Resnick's (1987) theory that higher order thinking cannot be defined exactly, but is recognisable when it occurs. Some of its essential properties are that it is :

- non-algorithmic
- complex
- self-regulated
- effortful
- applies multiple criteria

This occurs when problems are exposed which cannot be solved through recall and application of previously learnt knowledge. What is required for problem solving is a form of creative thinking or "going beyond the information given" (Bruner 1971). Higher level thinking is regarded as a desirable educational goal as it is linked to achievement, effective problem solving capacity and greater self-realisation (Rowe 1993; Mayer 1992). The contexts that produce higher level thinking are diverse, and include processes of reading and mathematical understanding. Thinking skills are teachable and learnable, and processes that are regarded as influential in cultivating thinking and reasoning skills in the classroom are:

- engagement in collaborative learning processes
- tackling problem solving tasks.

In addition, discourse which involves a high level of learner initiation is indicative of higher order learning processes. Previous research provides evidence that the following categories of talk are indicators of higher order thinking and learning.

- explanations and elaborations (Webb, 1989);
- specific questions and counter assertions (Meloth & Deering, 1994);
- question generation (Hilton, 1990; Graesser, 1994);
- detailed explanations of problem solving behaviours (Webb, 1991);
- demonstrating level of understanding (Webb, 1994);
- giving elaborate explanations to peers (Webb, 1989);
- task related questioning and strategy elaboration (King, 1989);
- guided co-operative questioning (King & Rosenshine, 1993);
- giving and receiving elaborated help (King & Farivar, 1994);
- question generation and explanation (King 1992).

There is a well recognised need for educators to focus their efforts on improving these higher-level cognitive skills to enable children to become independent and productive learners and thinkers. With rapid technological change students clearly need to learn not only subject matter, but also new information handling skills and analytical strategies they will require throughout their lives.

Can Higher Order Thinking Skills be Taught Via Telematics?

Clearly, different pedagogical outcomes require different particular patterns of interaction. Demonstrating to teachers the range of options in teaching approaches together with increasing awareness of the impact of their teaching practices on student behaviours is a step in the right direction. Teachers can become more aware of their teaching approaches and attendant limitations by viewing the behaviours of their students as they learn via telematics. This is best achieved by videotaping the lessons delivered to the remote site. Teachers then engage in action research by looking at the classroom situation, developing a practice in response, trying out the practice,

observing what happens and revising the practice as necessary. Teachers involved in the Academic Talent Program now ask questions such as:

- *How do high ability students respond to the tasks and activities in my lessons?*
- *Are these learners engaging in higher order cognitive processes, problem generation, reasoning and critical thinking?*
- *What teaching strategies can I use to establish meaningful learning experience for students to develop higher order learning?*

Instructional Design Framework for Higher Order Learning

In order to orchestrate interactions leading to higher order learning, three dimensions to a design framework were considered for telematics teaching, using constructivist approaches to learning (Duffy, Lowyck and Jonassen, 1993). A sketch of the issues that need to be considered are as follows:

1. *Role of the teacher in the learning process.* To what extent is the teacher an authoritative provider of knowledge as opposed to a resource? What additional roles could teachers perform, other than to initiate questions and mange the lesson?
2. *Role of the student.* How can students demonstrate autonomy, self direction and ownership of the activities throughout the lesson? How can they be encouraged to engage in higher order processes such as evaluating and problem solving?
3. *Teaching strategies.* What teaching methods and corresponding activities should be used to achieve the instructional goals of higher order learning? How should these activities be sequenced to optimise learning?

These issues inform the framework adapted from the research of Shuell (1988) depicting the role of the learner in instruction, and incorporate the findings of Kinzie (1990) who investigated the requirements of successful instruction. Kinzie (1990) defined the essential elements of self-regulated learning as enabling students to control their own learning, thereby increasing motivation and engagement. Telematics environments have the potential to foster self-directed and autonomous learning through appropriate use of the technology and orchestration of interactions with learners.

A preliminary step in the creation of a framework to guide telematics teachers is to specify the essential functions a learner must engage in to learn from instruction. This contrasts with the observed patterns of interaction observations of telematics classrooms (McLoughlin & Oliver, 1995) where teacher talk dominated and there was little evidence of student participation or engagement in cognitive, affective or metacognitive functions.

The framework is intended to enable teachers to help learners take appropriate steps to control their learning by creating opportunities for dialogue and reciprocal action. The aim is to orchestrate the learning experiences so that increased learner input and control is fostered. In this way, the telelearning environments can bring about progressive, social, interactive participation where learners can develop cognitive and metacognitive strategies to enhance their own learning. Table 1 represents those functions which the teacher initiates in order to bring about learning, but most importantly, shows that at every stage the learner must also be engaged in a reciprocal action.

Summary and Conclusions

This article began by noting the limitations of telematics environments, and the didactic teaching style adopted by many teachers as they try to accommodate their teaching styles to the medium. In order to maximise use of the technology for delivery of lessons to remote learners while meeting the requirements of the academic talent program, the emphasis has been on self directed learning and authentic interactions as key strategies to guide the creation of such environments. The focus of the framework is to enable teacher to create an environment which is meaningful to students, enabling them to take responsibility, pose questions and self-evaluate their own learning. The verbal skills and strategies that students employ are key elements of the framework as it is through the discourse of such verbalisation that higher order cognition can be evaluated.

The framework is only a starting point for developing higher order learning. Observations of the learners as they engage in problem generation, critical analysis, consideration of alternative solutions and evaluation of alternative perspectives will lead to better understanding of how telematics environments can be designed to enhance higher order learning.

Function	Teacher initiated	Student initiated	Active Learner Role/Strategy
Lesson objectives	specify instructional outcome	identify or state purpose of lesson state expectations	self-direction (metacognitive)
Building on prior knowledge	discuss context, investigate level of understanding	present examples, discussion and brainstorming	learning strategies, mnemonics
Supporting student responses	explains, cites examples, contextualises	generates examples, creates images	elaboration, verbal extension
questioning	asks questions checks understanding	self questioning, hypotheses generation, asking "what if questions?"	stimulation of curiosity, internal processing
feedback	provides positive and negative feedback correct responses	group monitoring, self testing	self regulation
evaluation	asks students to evaluate their own performance	express what is known, not known identify gaps in understanding	personal causation and involvement

Table 1: Guided Learning Model to promote higher order learning

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